

Effect of Planting Date on the Efficacy of an In-Furrow Pesticide and the Development of Cotton Seedling Disease

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ABSTRACT

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In studies to evaluate the effect of planting date and application of aldicarb + TSX on the development of seedling diseases of cotton (*Gossypium hirsutum*), disease was assessed by quantifying seedling populations and indexing surviving seedlings. In both 1985 and 1986, eight planting dates between 4 April and 16 May were evaluated. Plant populations generally increased with later planting dates. The increase in plant populations over planting date for the untreated plots was described by a cubic equation ($R^2 = 0.33$) in 1985. No significant relationship was observed for the plots treated with aldicarb + TSX. In 1986, the relationship between plant populations and planting date was described by a cubic equation for the treated and untreated plots ($R^2 = 0.85$ and 0.86 , respectively). The application of aldicarb + TSX also increased seedling stand density compared with the controls. Values of the disease indices were higher for the early plantings and lower in the later plantings. The decline in disease index over planting dates in 1985 was described by a quadratic equation for the untreated plots ($R^2 = 0.86$) and by a cubic equation for the treated plots ($R^2 = 0.87$). In 1986, the relationship between disease index and planting dates was described by a cubic equation for untreated and treated plots ($R^2 = 0.69$ and 0.52 , respectively). Values of the disease index were significantly reduced by the application of aldicarb + TSX at all planting dates.

Despite the widespread use of fungicides applied in the planting furrow, seedling diseases of cotton (*Gossypium hirsutum* L.) are still a major problem in cotton production areas. In 1986, a nationwide cotton production loss of 2.2% was attributable to seedling diseases, which represents the largest single loss in cotton caused by disease (7). Recommended practices for managing seedling diseases include planting certified, fungicide-treated seed, applying in-furrow fungicides, and delaying planting until soil temperatures increase (2,11,12,16,19).

Although delaying planting until soil temperatures increase will reduce the incidence of seedling diseases, many growers still apply in-furrow fungicides to late-planted cotton. The combination fungicide, 10% pentachloronitrobenzene (PCNB) plus 2.5% etridiazol (Terraclor Super X, TSX) (Uniroyal Chemical Co., Inc., Middlebury, CT), provides good control of seedling disease and is used widely throughout the cotton belt (11,12). Aldicarb (Temik 15G, Rhone-Poulenc Agricultural Co., Research Tri-

angle Park, NC), an insecticide/nematicide, is often applied in combination with TSX to control early season insects and nematodes. The combination is used widely in Louisiana. Research at the Red River Research Station has shown that cotton stands in early plantings can be improved with the application of aldicarb + TSX (3). The objective of this study was to evaluate the effect of planting date and aldicarb + TSX on cotton stand establishment and to determine the effect of planting date on the efficacy of application of aldicarb + TSX for management of seedling diseases.

MATERIALS AND METHODS

Experiments were conducted on a Norwood very fine sandy loam at the Red River Research Station in Bossier City in 1985 and 1986. Tests were arranged in a split-plot design with four replications. Main plots were planting dates and split plots were in-furrow treatments (\pm aldicarb + TSX). Main plots were eight rows planted on 102-cm centers by 64 m and split-plots were four rows by 64 m. Actual planting dates, which represent the range of the planting dates recommended for Louisiana, were 4, 9, 11, 17, and 22 April and 8, 13, and 16 May 1985; and 3, 11, 18, 24, and 30 April and 7, 12, and 16 May 1986.

Seed bed preparation and fertilization was completed on 15 and 19 March in 1985 and 1986, respectively. Nitrogen was applied as anhydrous ammonia at 56 kg N/ha in 1985 and 67 kg N/ha in 1986. Deltapine 41 cottonseed double-

treated with captan plus carboxin was used throughout the study. Aldicarb + TSX (Temik 15 G at 0.56 kg a.i./ha plus Terraclor Super X at 1.4 kg a.i./ha) was applied in-furrow at planting with a four-row planter equipped with granular applicators.

Seedling disease was assessed by quantifying plant stands and applying a disease index to the roots and hypocotyls of surviving seedlings. Surviving plants were counted in the two center rows of each plot 2 wk after planting. The root-hypocotyl disease index was taken 4 wk after planting. Twenty seedlings selected at random were removed from the soil, washed under tap water to remove any adhering soil, and evaluated for root and hypocotyl necrosis. The disease index was as follows: 0 = no necrosis, 1 = <33, 2 = ≥ 33 to <66, 3 = ≥ 66 to $\leq 100\%$ necrosis on the roots and/or hypocotyl, and 4 = dead tap root with adventitious lateral roots developing above the dead area.

Isolations were made from 4-wk-old cotton seedlings to identify causal agents. Seedlings were removed from the field and washed under tap water to remove any adhering soil. Necrotic root and hypocotyl tissue was excised from the seedling, submerged in 70% ethanol for 30 sec, and surface-disinfested in 0.5% (w/v) NaOCl for 3 min. Tissue samples were plated on potato-carrot agar acidified to pH 4.0 with lactic acid and incubated in the dark at 24 C for 7 days.

Weather data were collected from a National Weather Service Cooperative Climatic Station located on the Red River Research Station approximately 200 m from the plots. Stand counts and disease index were subjected to analysis of variance to determine main and split-plot effects. Mean separations were performed on plant populations and the disease index with Duncan's multiple range test. Student's *t* test was used to determine the significance of differences in disease index between treatments at each planting date. Regression analysis was used to determine effects of planting date on plant populations and disease index.

RESULTS

Soil temperatures for April and May 1985 were comparable to the 20-yr average and increased throughout the planting season. Minimum soil temperatures

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at 10 cm were 14, 20, 23, and 24 C on 1 and 15 April and 1 and 15 May, respectively. Rainfall for the first part of April was below the 20-yr average, but 2.39 cm of rain on 31 March was adequate for seed germination. Between 22 April and 8 May, 10 cm of rain was recorded. Because of these rains, no cotton was planted between 23 April and 8 May.

In 1986, soil temperatures were above the 20-yr average through the first 2 wk of April and dropped slightly until the end of the month. Minimum soil temperatures were 19, 17, 21, and 24 C on 1 and 15 April and 1 and 15 May, respectively. Rainfall for April and May 1986 was similar to the 20-yr average. Although the total amount of rainfall in April was comparable to the 20-yr average, most of the rain occurred on two dates—1.88 cm on 12 April and 6.38 cm on 20 April. There was no precipitation between 12 March and 11 April.

The dry conditions in early April impaired seed germination and stand establishment for the first two plantings.

Plant populations. Differences ($P = 0.01$) in plant populations occurred among planting dates and between in-furrow treatments in both years, but the interaction was not significant. Because there was no significant interaction between planting date and in-furrow treatment in either year, in-furrow treatments were averaged across planting dates and planting dates were averaged across in-furrow treatments. Plots treated with aldicarb + TSX had significantly higher plant populations than the untreated plots. In 1985, the plant population (plants per 30.5 m) of all treated plots combined was 12.1% greater than untreated plots. Plant population of all treated plots combined was 12.9% greater than untreated plots in 1986.

The effect of planting date on plant populations was much greater in 1986

than in 1985. In 1985, plant populations increased slightly in late April and early May and then declined slightly in mid-May (Fig. 1). For the untreated plots, this relationship was described by a cubic relationship. However, it was not significant for the plots treated with aldicarb + TSX. In 1986, plant populations were low in early April, increased in late April and early May, and remained the same in mid-May (Fig. 2). This relationship was best described by a cubic relationship for both treated and untreated plots.

Seedling disease development. Mean values for the disease index were significantly different between in-furrow treatments and among planting dates in both years. Application of aldicarb + TSX resulted in significantly lower disease indices on all planting dates in both years, except 13 May 1985. The differences in disease indices between treatments were small for the May planting dates.

Analysis of variance showed a significant interaction between planting date and in-furrow treatment for both years. This relationship was described by a quadratic equation for the untreated plots and by a cubic equation for the treated plots in 1985 (Fig. 3). In 1986, the relationship was best described by a cubic model for both treatments (Fig. 4). Disease indices were high throughout April and declined in May. The highest disease indices were recorded on 17 and 22 April 1985.

The principal fungi isolated from necrotic seedlings were *Rhizoctonia* spp. and *Fusarium* spp. *Rhizoctonia* spp. were isolated from 43 and 35% of the seedlings in 1985 and 1986, respectively. *Fusarium* spp. were recovered from 41% of the seedlings in 1985 and 39% in 1986. *Pythium* spp. were isolated less frequently (8 and 6% in 1985 and 1986, respectively).

DISCUSSION

Several factors affect the development of seedling disease. Temperature and moisture are two of the most critical factors (16,17,19). Other factors include seed quality (2,11,12,16,19), nematodes (17,18), insects (13,19), insecticides and herbicides (16,17,19), planting depth (9,12,16,19), and density and virulence of pathogen inoculum (9,12,19).

In this study, populations of cotton seedlings generally increased with later planting dates. Other researchers have reduced seedling disease losses by planting later when soil temperatures have increased (5,6,10). The effect of planting date on plant population was much greater in 1986 than in 1985. In 1985, soil moisture was adequate but not excessive, whereas soil temperatures were comparable to the 20-yr average and increased as planting was delayed. Plant populations were reduced because pre-emergence damping-off was most severe

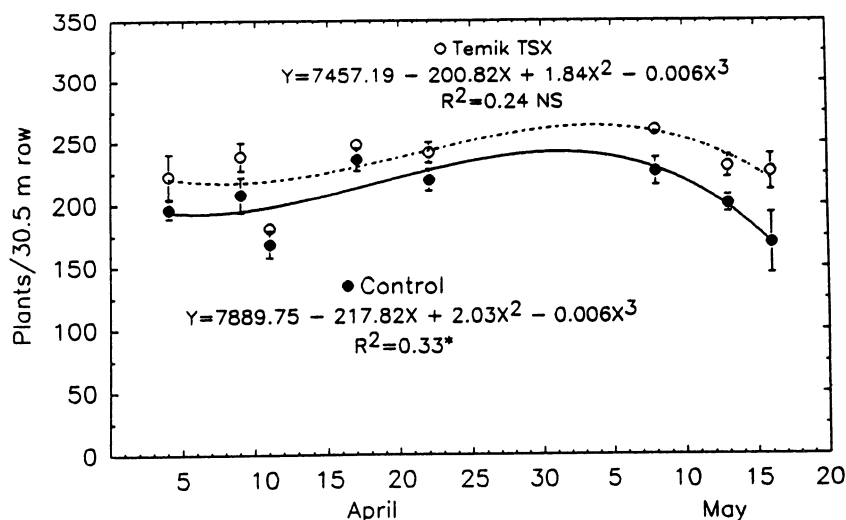


Fig. 1. The effect of an untreated control and the in-furrow application of aldicarb + TSX on the relationship between planting date and seedling population, 1985. * = Significant at $P = 0.05$.

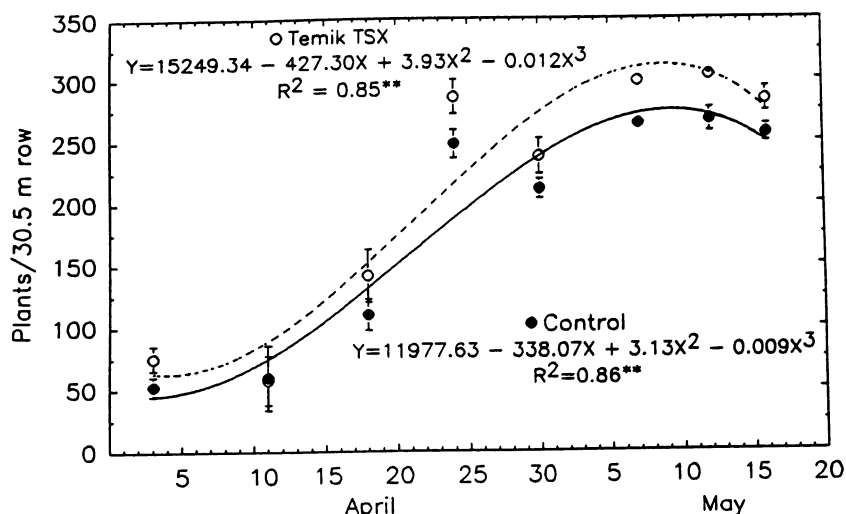


Fig. 2. The effect of an untreated control and the in-furrow application of aldicarb + TSX on the relationship between planting date and seedling population, 1986. ** = Significant at $P = 0.01$.

during the early plantings when soil temperatures were cooler. In 1986, soil moisture was below the 20-yr average for the early plantings, and soil temperatures were slightly above the 20-yr average. The reduction in plant populations in the early plantings in 1986 was attributed to the unusually dry conditions that impaired seed germination and seedling survival. The reason the effect of planting date on seedling survival was much greater in 1986 than in 1985 is unknown. Because of cooler soil temperatures in 1985, higher incidence of seedling disease and death were expected. Apparently, other factors, such as pathogen inoculum density, soil compaction, and nematode infestation, acting independently or together, were involved in seedling mortality.

Plant populations averaged across all planting dates were improved by the application of aldicarb + TSX both years. The application of aldicarb + TSX has previously been reported to improve seedling stands (3,11). The combination fungicide, PCNB plus etridiazol, provides excellent control of seedling diseases caused by *Rhizoctonia* and *Pythium* (11,12). The addition of aldicarb provides protection from early season insects and nematodes, which predispose plants to seedling diseases (13,17,19). Lack of a significant interaction between planting date and in-furrow treatment on plant population in either year indicates the influence of aldicarb + TSX on seedling survival was not affected by planting date.

Although plant populations were not greatly reduced for the early planting dates in 1985, disease indices and random isolations from surviving seedling indicate seedlings were being infected. Non-lethal infection of cotton seedlings that results in stunting, delayed fruiting, and reduced yields has been reported by others (1,14,15,18). Because of these non-lethal effects, reduction in disease index may be as important as seedling survival. The reduction in the value of disease indices at every planting date with the application with aldicarb + TSX further justifies its application.

In both years, disease index values were high in early April and declined in late April and early May. The reduction in disease index values in the later plantings was attributable to the warmer soil temperatures. Warmer temperatures favor rapid seedling growth and reduced fungal infection of cotton seedlings (2,4,6,11,16). Although differences in disease indices between in-furrow treatments were small for the later plantings, application of aldicarb + TSX resulted in significantly lower values for the disease indices on nearly every planting date. The high disease index recorded for 17 and 22 April 1985 were probably the result of the wet conditions caused by persistent rains between 22 April and 1 May of

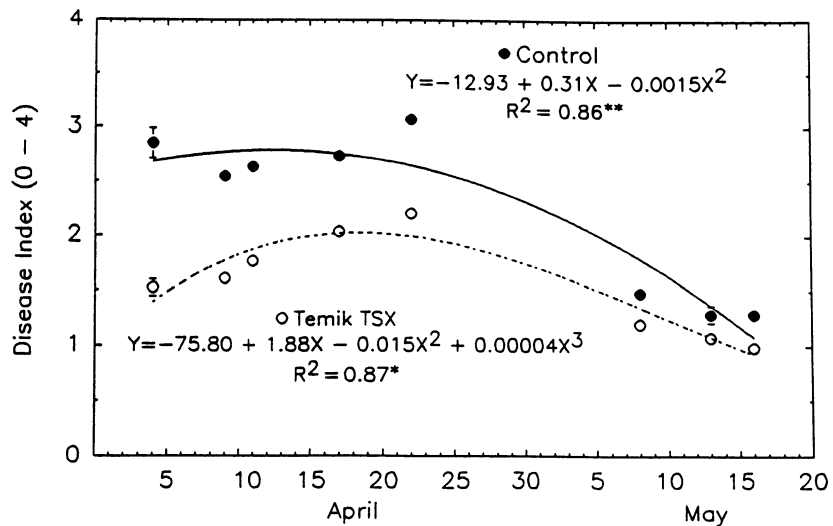


Fig. 3. The effect of an untreated control and the in-furrow application of aldicarb + TSX on the relationship between planting date and disease index, 1985. ** = Significant at $P = 0.01$; * = significant at $P = 0.05$.

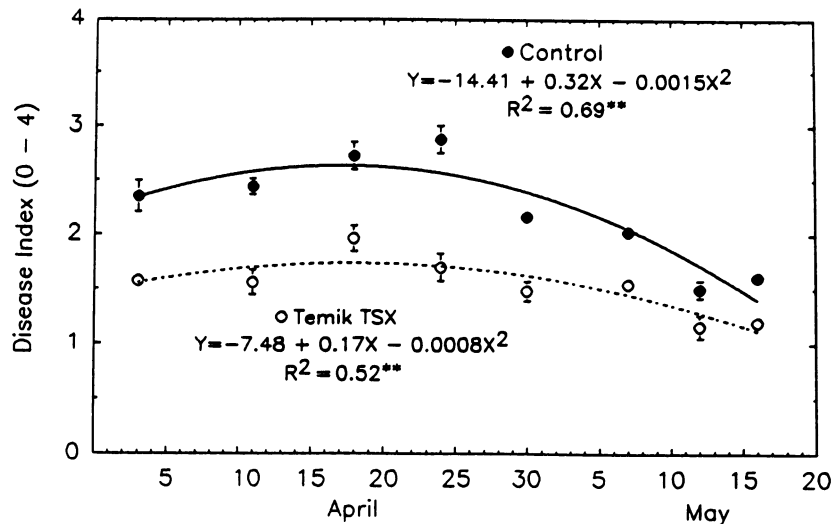


Fig. 4. The effect of an untreated control and the in-furrow application of aldicarb + TSX on the relationship between planting date and disease index, 1986. ** = Significant at $P = 0.01$.

that year.

The application of aldicarb + TSX generally improved seedling survival and reduced disease indices for the planting dates used in this study. These dates represent the range of normal, as well as extreme, cotton planting dates for Louisiana. Thus, the application of aldicarb + TSX could be justified whenever cotton is planted to improve seedling survival and health. However, a final decision should be based on economic aspects. Some reduction in seedling populations may be acceptable because of the ability of the cotton plant to compensate and grow into open spaces (8). However, the effects of nonlethal seedling infections should be considered. An informed decision would require more analysis of the effect of the plant populations and seedling health on yield and of early season control of insects and nematodes that affect seedling survival.

LITERATURE CITED

- Batson, W. E., Jr. 1982. Effect of selected seed treatments on incidence of *Rhizoctonia solani* and *Fusarium* species on cotton seedlings. Page 29 in: Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council of America, Memphis, TN.
- Bird, L. S. 1981. Pest management systems of cotton diseases. Pages 203-213 in: Handbook of Pest Management in Agriculture. Vol. 3. D. Pimental, ed. CRC Press, Boca Raton, FL.
- Colyer, P. D., Snow, J. P., Melville, D. R., and Barker, F. G. 1987. In-furrow pesticides for cotton seedling disease control. La. Agric. 30:18-20.
- Fulton, N. D., and Bollenbacher, K. 1959. Pathogenicity of fungi isolated from diseased cotton seedlings. Phytopathology 49:684-689.
- Fulton, N. D., Waddle, B. A., and Thomas, R. O. 1956. Influence of planting dates on fungi isolated from disease cotton seedlings. Plant Dis. Rep. 44:793-795.
- Garber, R. H. 1986. Early season production management practices: Diseases. Pages 8-10 in: Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council of America, Memphis, TN.
- Gazaway, W. 1987. Cotton disease loss estimates report—1986. Page 5 in: Proc. Beltwide Cotton

- Prod. Res. Conf. National Cotton Council of America, Memphis, TN.
8. Halloin, J. M. 1983. Estimation of losses due to seed and seedling diseases. Page 26-27 in: Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council of America, Memphis, TN.
 9. Hernandez, V., El-Zik, K. M., and Bird, L. S. 1987. A discriminant analysis of several factors contributing to the seed-seedling disease complex of cotton. Page 29 in: Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council of America, Memphis, TN.
 10. McCarter, S. M., and Roncadori, R. W. 1971. Influence of low temperature during cottonseed germination on growth and disease susceptibility. *Phytopathology* 61:1426-1429.
 11. Minton, E. B. 1986. Half a century dynamics and control of cotton diseases: Seed-seedling diseases. Pages 33-35 in: Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council of America, Memphis, TN.
 12. Minton, E. B., and Garber, R. H. 1983. Controlling the seedling disease complex of cotton. *Plant Dis.* 67:115-118.
 13. Neal, D. C., and Newsom, D. 1951. Soreshin of cotton and its relationship to thrips damage. *Phytopathology* 41:854.
 14. Roncadori, R. W., Hendrix, F. F., Jr., and Powell, W. M. 1968. Fungi affecting cotton root growth. Page 42 in: Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council of America, Memphis, TN.
 15. Roncadori, R. W., and McCarter, S. M. 1972. Effect of soil treatment, soil temperature, and plant age on *Pythium* root of cotton. *Phytopathology* 62:373-376.
 16. Rude, P. A. 1984. Integrated Pest Management for Cotton in the Western Region of the United States. University of California Press, Oakland. 144 pp.
 17. Sinclair, J. B. 1965. Cotton seedling diseases and their control. La. State Univ. Agric. Exp. Stn. Bull. 590. 35 pp.
 18. Wallace, T. P., El-Zik, K. M., and Bird, L. S. 1983. Response of cotton cultivars to the seedling disease complex and stand establishment under two soil temperatures. Page 35 in: Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council of America, Memphis, TN.
 19. Watkins, G. M., ed. 1981. Compendium of Cotton Diseases. American Phytopathological Society, St. Paul, MN. 87 pp.